

"The Value of Lumbar Puncture as an aid  
to Diagnosis and Therapeutics."

A Thesis presented for the  
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by

Archibald Gillespie, M.B.

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The Value of Lumbar Puncture as an aid to  
Diagnosis and Therapeutics.

Since Quincke, in 1891, first pointed out how the cerebro-spinal fluid could be drawn off by a needle inserted into the sub-arachnoid space, between the transverse processes of the lumbar vertebrae, in other words by Lumbar Puncture, a vast amount of work has been done on the subject by many observers.

Quincke first used lumbar puncture to relieve the excessive intracranial tension in cases of chronic hydrocephalus, as a substitute for the customary and more serious operation of tapping the ventricles. It was thus for therapeutic purposes that lumbar puncture was introduced, but, though it has been recognised that it is sometimes a useful therapeutic agent, it is undoubtedly as will be seen later, as an aid to diagnosis that lumbar puncture promises to be of most value.

THE TECHNIQUE OF LUMBAR PUNCTURE.

The patient may be placed in either of two positions i.e. sitting up with his head bent forward or lying on his side. The lateral position is the one that is almost universally used now, as it is the safer and more convenient. The patient lies on his side, with his knees drawn up, and his head approximated as far as he can to his knees, to produce as much arching of the spinal column as possible.

A hollow needle from two to four inches in length is chosen. Care must be taken to see that the needle is tempered sufficiently tough to ensure its bending rather than breaking.

It is usual to introduce the needle between the 3rd and 4th lumbar vertebrae, but the puncture may also be made between the 4th and 5th lumbar vertebrae, or between the 5th lumbar vertebrae and the sacrum. We will suppose that the puncture is going to be made in the usual place i.e. between the 3rd and 4th lumbar vertebrae. An imaginary line is drawn through the highest points of the iliac crest and a spot is chosen half an inch below and external to the tip of the vertebral spine intersected by this line. This is the point at which the needle is /



is to be inserted. The skin over this region is carefully cleaned up as before other surgical operations. The needle, which has previously been boiled, is then introduced at the spot indicated above and pushed in a slightly upward and inward direction. If bone is felt the direction of the needle must be slightly altered, and after a little gentle probing the needle will be felt to slip through the comparatively soft Ligamenta Flava and membranes into the subarachnoid space. We recognise that this has taken place by the absence of any further resistance, and by the escape of cerebro-spinal fluid from the needle. If the needle be pushed too far it may be felt to come in contact with the body of the vertebra. If this happens, the needle must be slightly withdrawn, when the fluid will begin to escape through it.

The depth to which the needle has to pass varies with the age and the muscularity of the patient. In children the operation is easy, but in a well developed man one may have to go through three inches of soft tissues before reaching the vertebrae, and here one must be prepared to find some little difficulty in finding the space between the transverse processes. The pain which the operation causes varies chiefly with the ease with which this space is/  
is/

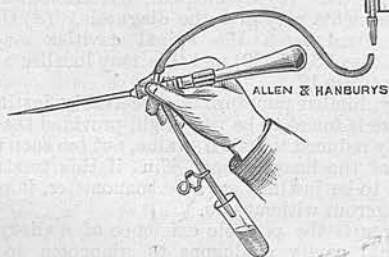
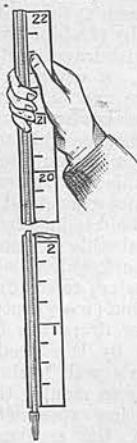


is found and the depth to which the needle has to be inserted. As a general rule, the pain does not seem to be any greater than that caused by aspiration of the chest. With nervous subjects a local anaesthetic may be used, a little cocaine may be injected under the skin and into the deeper tissues, or the part may be frozen with the ethyl chloride spray. A drop of pure carbolic placed on the spot where the needle is to be inserted is useful as a local anaesthetic and an antiseptic. In children it is well to administer a little chloroform, as without it, it is difficult to get them to keep sufficiently still during the operation.

It sometimes happens that after having succeeded in reaching the subarachnoid space, no fluid escapes from the needle. This may be owing to the needle being blocked by blood clot, resulting from the puncture of a vein during the insertion of the needle. The lumen of the needle may then be cleared by a blunt stillette. It might also be caused by one of the nerves of the cauda equina lying close against the point of the needle and this can be remedied by moving the point of the needle.

Sometimes however, one absolutely fails to obtain any fluid, and the probable explanation in these cases is that a part of the subarachnoid space has/

To face page  
5.



has been shut off by adhesions and contains no cerebro spinal fluid.

Blocking of the Foramen of Majendie by flakes of lymph is sometimes the cause of failure to obtain fluid in cases of meningitis.

When we have reached the subarachnoid space and the fluid contained in it, the next thing to do is to measure the pressure under which the cerebro spinal fluid exists. This may be done by any form of manometer. The most convenient perhaps for clinical purposes, and the one of which the author has most experience is that introduced by Eve and described by him in the Lancet of April 22nd 1905. An illustration of Eve's instrument is given on the opposite page. When the needle has been introduced and the cerebro-spinal fluid appears at the exit tube, the exit tube is clamped and the fluid flows up the manometer tube. The height to which it rises is read off on the scale which is marked in inches. Sometimes there is some difficulty in getting the fluid to rise in the manometer tube. This can as a rule be overcome by pinching or milking the rubber tubing. Forcible aspiration with a syringe is dangerous and should never be used.

Two oscillations in the pressure are clearly seen/



seen in the manometer tube; one the more extensive corresponding to the respirations, and the other to the heart beats. When the pressure is abnormally high the respiratory wave is usually much diminished while the pulse wave is still clearly seen.

After the pressure has been ascertained the manometer tube is clamped and the clamp on the exit tube removed and the fluid which now trickles from the exit tube is collected in a tube. When a sufficient amount of fluid has been withdrawn, for diagnostic purposes or to reduce an abnormally high pressure, the needle is withdrawn and the puncture wound covered by a little collodion.

Let us now consider what is the normal pressure of the cerebro-spinal fluid in a state of health and how it varies in disease. The first observers were met with the difficulty, that in apparently healthy subjects they found wide variations existing in the pressure under various conditions, and it was difficult to decide what was the average cerebro-spinal pressure in a normal state of health. When they came to test it in the course of different diseases the divergencies of opinion were still more marked, some finding a high pressure, others a low pressure in the course of the same disease, while some failed to obtain fluid which sometimes indicates the absence/

the absence of any pressure at all. The first observer to come to any trustworthy conclusions was Pfaundler. He pointed out <sup>(1)</sup> that the pressure is made up of three elements, viz. hydrostatic, vascular and elastic. The hydrostatic element is the pressure which the column of cerebrospinal fluid exerts when the patient is in the erect position, and which disappears when the patient lies down. The elastic element is that furnished by the walls of the subarachnoid space and the ventricles of the brain, which, when the amount of fluid is increased, tend by their elasticity to compress the fluid. As the whole central nervous system is contained in a complete bony case which prevents distention of the cavities, the elastic element in the pressure is not very great. It can be measured post mortem with the body recumbent and usually equals about 2 mm. of mercury, although it may be increased to 10 mm. The third and by far the most important element in the pressure is the vascular or that exerted by the heart through the blood vessels.

Pfaundler gives the normal subarachnoid pressure in the sitting position as from 20 - 25 mm. of mercury. About/

(1) Jabruch f. Kinderheilkunde 1889. Bd 49.



About half of this is hydrostatic and disappears when the patient lies down.

Quinke<sup>(1)</sup> gave it as being normally equal to a pressure of 20 - 40 mm. of water with the patient on his back, and considers that an increase of pressure to 150 mm. of water is to be considered as pathological.

Eve<sup>(2)</sup> gives the normal pressure as from 3 - 8 inches (75 - 200 mm.) of water.

The cerebro-spinal pressure has been found to be often much increased in meningitis, hydrocephalus, tumour of the brain, chlorosis, after injuries to the head, and in toxic states, such as those found in uraemia, lead poisoning and in the course of the infectious fevers.

In tubercular meningitis the increase of pressure is usually very marked and a pressure of 100 mm. of mercury has been recorded. In a case of this disease which came under the writer's observations, the pressure which was measured by Eve's manometer equalled a pressure of  $15\frac{1}{2}$  inches of water. The pressure in cases of <sup>tubercular</sup> meningitis increases from the initial stages up to that of pressure symptoms, and diminishes/

(1) Berlin Klin. Woch. October 14th 1895.

(2) Lancet. April 22nd. 1906.



diminishes towards the close of the disease.

Pfaundler gives the following measurements as typical of tubercular meningitis.

First stage = 48 mm. of mercury.  
 Stage of pressure = 52 mm. of mercury.  
 Stage of paralysis = 24 mm. of mercury.

In suppurative meningitis the pressure has been found to vary from 10 - 37 mm. of mercury, in cerebro spinal meningitis from 24 - 50 mm. in hydrocephalus from 6 - 60 mm. and in brain tumor from 3 - 52 mm. of mercury (Quinke and Pfaundler).

A moderate increase of pressure accompanied by grave compression symptoms points to an acute disease, while a large increase of pressure, with less marked signs of compression indicates a chronic condition (Quinke<sup>(1)</sup>).

#### THE CHARACTERS OF THE CEREBRO SPINAL FLUID IN HEALTH.

It is a faintly alkaline, sterile and perfectly clear and colourless fluid. Its specific gravity varies from 1001 - 1006. The chief inorganic constituent is sodium chloride, but it also contains traces of carbonates and phosphates. The amount of inorganic/

(1) Berlin Klin. Woch. October 14th 1895.

inorganic salts = 8 parts in 1000. A reducing substance belonging to the pyrocatechin class of compounds is also present. Comba<sup>(1)</sup> says that in children the average amount of reducing substance is from 4 to 5 centigrammes per 100.

The cerebro-spinal fluid has usually been stated to contain albumin, but it is now proved that the proteid matter present is not a true albumin but a globulin. As most writers refer to it as albumin it will be convenient, though not quite accurate, to refer to it subsequently under that name. The amount of the proteid matter is usually given as 0.2 parts in 1000. Quincke<sup>(2)</sup> gave it as from 0.2 to 0.5 parts per 1000. The highest amount reported is according to Hand<sup>(3)</sup> one part in 1000.

According to most authorities the cerebro spinal fluid in health never contains any cells or other morphological elements, but Earl<sup>(4)</sup> holds that if it is examined with great care, a few cells may occasionally be found.

(1) Clinica Medica 1899.

(2) Berlin. Klin. Woch. October 14th 1895.

(3) Amer. Jour. of the Med. Sciences. Oct. 1900.

(4) Dublin Journal of Med. Sciences. Dec. 1903.



Ceconi<sup>(1)</sup> has made elaborate researches into the the cryoscopic phenomena of cerebro-spinal fluid. He finds that the depression of the freezing point (known as  $\Delta$ ) of normal cerebro-spinal fluid is equal to that of normal lymph, i.e.  $\Delta = 0.58^{\circ}\text{C} - 0.60^{\circ}\text{C}$ ; but greater than that of defibrinated blood.

The cerebro-spinal fluid is now looked upon as a fluid "sui generis," differing from all the other fluids of the body. Most authorities now agree that it is secreted by the choroid plexus in the lateral ventricles, and that it then escapes into the third ventricle, thence by the iter into the fourth ventricle, and from this by the foramen of Majendie into the subarachnoid space. From this it passes by the perivascular and perineural lymphatics into the lymphatic system. The cerebro-spinal fluid is now supposed to play the same part in the nutrition of the tissues of the central nervous system, as lymph does in the nutrition of the other tissues of the body.

#### THE CERE BRO - SPINAL FLUID IN DISEASE:-

Having obtained a sufficient amount of fluid by lumbar puncture from any given case, one may proceed/

(1) Riv. Crit. di Clin. Med. 1905 No.27 - 32.



proceed to examine it in various ways, viz.

- (1) by naked eye examination.
- (2) chemically
- (3) cytologically
- (4) bacteriologically
- (5) cryoscopically.

Let us now consider each of these methods of examination in detail, and see how in these various ways, the cerebro-spinal fluid may, in pathological conditions, show departures from what we expect to find in the normal fluid.

#### (1) Naked eye examination:-

Instead of being a clear fluid the cerebro-spinal fluid may be found to be cloudy, seropurulent or altogether purulent. In purulent meningitis one commonly finds all these grades of turbidity. The fluid may be blood stained. Its colour may vary from a pinkish tinge to a deep red colour. The presence of blood in the cerebro-spinal fluid may be due to various causes. It is sometimes caused by the accidental puncture of a vein during the insertion of the needle. Blood is found in the cerebro-spinal fluid also in cases of fracture of the skull or spine with rupture of the dura mater, in cases of severe laceration/

laceration of the brain with rupture of the pia mater, in subdural haemorrhage and in cases of haemorrhages in the substance of the brain with rupture into the ventricles, and also in some cases of meningitis.

It is often very difficult to decide whether the blood is due to puncture of a vein, or to some cause existing before the operation. If there is blood in the first part of the fluid obtained, but none in the rest, or if the amount of blood in the fluid varies from moment to moment, it points to puncture of a vein. Another distinguishing point is, that, when the blood has come from a punctured vein it clots on standing and falls to the bottom of the tube. This never takes place when the presence of blood is due to other causes. (Ceconi <sup>(1)</sup>) An immediate microscopical examination of some of the fluid will, when the blood is due to puncture of a vein, show unchanged red blood corpuscles, but when the blood is due to other causes existing before the puncture was made, the red cells will be more or less disintegrated.

The cerebro spinal fluid has been found to have a yellowish or greenish tinge in some chronic cases of jaundice (Widal, Sicard and Ravant <sup>(2)</sup>).

(1) Riv. Crit. di Clin. Med. 1905 No.27 - 32.

(2) Soc. de Biologie. Feb. 8th 1902.



After standing for some time the fluid may deposit a network of fibrin. This never takes place in normal fluid, but always in cases of meningitis. This deposit of fibrin is best seen in cases of tubercular meningitis. If some of the fluid from one of these cases is put into a tube and held up to the light, myriads of highly refracting particles will be seen floating about in the fluid. These have been likened to motes in a sunbeam and are due to the coagulation of the fibrin. After 24 hours or so, if the tube is kept in an upright position, a cobweb-like funnel shaped coagulum will be formed, beginning a little below the surface of the fluid and extending downwards, the broadest part of the funnel being above (Koplik<sup>(1)</sup>).

Although this appearance may be found in all kinds of meningitis, Koplik thinks that when it is well seen, it points strongly to a tubercular meningitis.

(2) The chemical examination of the cerebro spinal fluid.

In some diseases the chemical composition of the cerebro-spinal fluid is found to vary from that of/

(1) Koplik "Diseases of Infancy and Childhood"



of the normal fluid, and diagnostic value is attributed by many observers, to the quantitative estimation of some of its constituents.

According to Comba,<sup>(1)</sup> the amount of reducing substance is diminished in the early stages of tuberculous meningitis, and towards the end it is absent altogether. In cases of meningitis due to the meningococcus of Weischelbaum and the diplococcus of Fraenkel, it is absent during the whole course of the case. The investigations of Bernstein<sup>(2)</sup> corroborate Comba's conclusions.

The amount of albumin is increased in cases of meningitis. Lenhartz<sup>(3)</sup> states that over 0.25 parts per 1000 points to inflammation, and most observers agree that as a general rule this is so, but it cannot be said to be conclusive as amounts of 2 to 4 parts per 1000 have been found in some cases of tumour and apoplexy (Hand<sup>(4)</sup>). In tubercular meningitis the increase of albumin is usually only slight, while in purulent meningitis it may be increased to 8 or 9 parts per 1000.

(1) Clinica Medica 1899

(2) Med. News. New York. June 17th 1905.

(3) Congress f. innere Medicin 1896. XIV.

(4) Amer. Journ. of Medical Sciences. October 1900.

Where there is disintegration of medullated nerve fibres going on as in cases of alcoholic neuritis etc., cholin and phosphoric acid may be found in the cerebro-spinal fluid, there being joint products of the disintegration of lecithin which exists in the myelin of nerves (Dana <sup>(1)</sup> ).

The cytological examination of the cerebro-spinal fluid:-

Having obtained a sufficient amount of fluid by lumbar puncture (10 c.c. is usually enough), it is now necessary to collect the cells that it contains for examination. The fluid should be centrifugalsed as soon as it is collected. If the centrifugalisation is not done at once, the fluid may deposit fibrin and a clot will form which will contain all the cells. Turton <sup>(2)</sup> recommends that when a clot has formed, the fluid should be shaken in a bottle containing a number of small glass beads. These break up the clot into a number of small pieces and the cells are set free, and on centrifugalising the fluid again, they fall to the bottom of the tube.

One/

(1) Medical Record. Jan. 23rd 1904.

(2) Practitioner. April 1905.



One now proceeds to make film preparations. A little of the sediment is sucked up from the bottom of the tube by a pipette and placed on a slide or coverglass. Fixing and staining are done <sup>in</sup> the same way as when making any other film preparations. Methylene blue and eosin, Erlich's stain etc. give good results.

To count the cells one uses the same method as in an ordinary blood examination, but it is not so much the exact number of cells present that is of importance but rather the relative proportion of the different kinds of cells.

Whether or not normal cerebro-spinal fluid ever contains cells, is a question which has given rise to a great deal of discussion.

Earl<sup>(1)</sup> first pointed out that if great care is taken a very few cells may sometimes be found in perfectly normal fluid.

Though Mott<sup>(2)</sup> and others deny this, it is now generally allowed that Earl's statement is correct. However, for all practical purposes it is sufficiently accurate to say that normally the cerebro-spinal fluid is devoid of cells and that their presence, to any appreciable extent may be taken to indicate some pathological condition.

(1) Dublin Journal of Med. Sciences Dec. 1903.

(2) Brit. Med. Journ. Dec. 10th 1904.



In pathological conditions we may find the cerebro-spinal fluid to contain lymphocytes, polynuclear leucocytes and occasionally endothelial cells.

Let us now pass to consider the result of the cytological examination of the cerebro-spinal fluid in various diseases.

#### I. In Meningitis:-

##### (a) Tubercular Meningitis.

Wentworth <sup>(1)</sup> in 1896 pointed out that in cases of tubercular meningitis, the cerebro-spinal fluid contained a great many lymphocytes, but very few polymorphonuclear cells.

Widal, Sicard and Ravant <sup>(2)</sup> insisted on the importance of a lymphocytosis of the cerebro-spinal fluid in the diagnosis of tubercular meningitis, <sup>and</sup> pointed out also that in other forms of meningitis, not a lymphocytic but a polynuclear leucocytosis was the rule.

Lutier <sup>(3)</sup> from an examination of 41 cases corroborated these deductions, and Percherons <sup>(4)</sup> observations/

(1) Archives of Pediatrics 1896. page 567

(2) Presse Médicale October 17th 1900.

(3) Thèse de Paris 1903.

(4) Thèse de Paris 1903.

observations led him to draw the same conclusions. Since then many observers have recorded similar cytological results, and it is now generally agreed, that a lymphocytosis of the cerebro-spinal fluid is almost constantly found in cases of tubercular meningitis.

Cases however have been recorded, where in undoubted cases of tubercular meningitis not a lymphocytic but a polymorphonuclear leucocytosis has been found.

Thus Marcon Mutzner<sup>(1)</sup> reported a case which was shown by autopsy to be tubercular, but in which the cerebro-spinal fluid contained only polymorphonuclear cells. It has also been found that later on in the course of a case of tubercular meningitis, the lymphocytosis may be replaced by a polynuclear leucocytosis. This however has in most cases been found to coincide with a secondary infection with pyogenic organisms.

## II. In other forms of meningitis.

In meningitis due to the pneumococcus, the streptococcus or the meningococcus, and in the cases/

(1) Archives Gén. de Médecine. Sept. 1901.



cases classed as posterior basal meningitis, Widal Sicard and Ravant and many other observers found that the majority of the cells present in the cerebro-spinal fluid were of the polymorphonuclear variety.

Hand<sup>(1)</sup> found a polynuclear leucocytosis whenever tubercle bacilli were not found.

Berdix<sup>(2)</sup> examined the fluid from three cases of cerebro-spinal meningitis. In two he found a polynuclear leucocytosis and in the third which ran a very chronic course a lymphocytosis was found.

Turton<sup>(3)</sup> found a polynuclear leucocytosis in two cases of posterior basal meningitis.

Horder<sup>(4)</sup> states that he has found in cases of meningitis due to the pyogenic organisms, that often 80% to 90% of the leucocytes present were polynuclear.

Many other observers have corroborated these results, and it is now proved that in meningitis due to the pneumococcus and the streptococcus, in cerebro-spinal meningitis and in posterior basal meningitis, a polynuclear leucocytosis of the cerebro-spinal fluid is the rule.

(1) Philadelphia Med. Journ. Aug. 30th 1903.

(2) Deutsche Med. Wochenschrift October 24th 1902.

(3) Practitioner- April 1905.

(4) British Med. Journ. October 21. 1905.



Labbé and Castaigne (1) however pointed out that the polynuclear leucocytosis, which is present in the acute stages of non-tubercular meningitis, is replaced later on by a lymphocytosis and that still later, when the condition is cured, the cells disappear from the fluid. The complete disappearance of the cells they say is often very slow, in one case lymphocytes were still present two months after. If there are relapses in the course of the case, each relapse is accompanied by an increase in the number of the polynuclear cells, or by their reappearance if they have already disappeared.

Labbé and Castaigne in one case found the polynuclear cells replaced by lymphocytes six days after the commencement of the disease, and they point out the necessity of remembering this secondary lymphocytosis, so as not to take a non-tubercular case in its later stages for a tubercular meningitis. This secondary lymphocytosis has also been noted by Horder (2) in chronic cases of meningococcus meningitis, but that it always takes place is not yet proved.

It/

(1) Soc. Méd. des Hôpitaux. March 29th 1901.

(2) Brit. Med. Journ. October 21st 1905.

It may here be noted that the same evolution of the cytological formula, a polynuclear followed by a lymphocytic leucocytosis, has been found by Ravant and Aubourg (1) in the reaction which follows the intraspinal injection of cocaine.

In Nervous and Mental Diseases:-

(1) In Tabes Dorsalis.

In 1901 Babinski and Nageotte (2) recorded the results of the cytological examination of the cerebro-spinal fluid from 26 cases of tabes. They found a lymphocytosis, more or less marked in 25 out of the 26 cases. Since then many observers have recorded similar results.

Widal, Sicard and Ravant (3) examined 37 cases, both recent and of old standing, and found a lymphocytosis in all the cases except one.

Brissaud and Baundet (4) found marked lymphocytosis in all of 8 cases.

Gombault (5) examined 19 cases and found an abundant lymphocytosis in 8. Out of 3 cases with no

(1) Soc. de Biologie. June 15th 1901.

(2) Soc. Méd. des Hôpitaux. May 1901.

(3) Revue neurologique. March 30th 1903.

(4) Revue neurologique. March 30th 1903.

(5) Ibid.

syphilitic history he found a lymphocytosis in two and none in the other.

Mallet <sup>(1)</sup> found lymphocytosis in 5 of 8 cases and Songues <sup>(2)</sup> in all of three cases, Marie <sup>(3)</sup> examined 20 cases of tabes which ranged in duration from 2 to 25 years. In six lymphocytosis was abundant, in ten more than a moderate amount, and in three moderate.

Fraenkel <sup>(4)</sup> found lymphocytes in all of 7 cases. In two, polynuclear cells were also present.

This lymphocytosis <sup>is</sup> found in atypical as well as typical cases of tabes, and in the very earliest stages. Thus Widal and Lemièrè <sup>(5)</sup> found it in a case where the only sign of the disease was the Argyll-Robertson pupil.

Nageotte <sup>(6)</sup> records a case where lymphocytosis of the cerebro-spinal fluid was the first definite sign of the disease.

#### In General Paralysis of the Insane.

Here also a lymphocytosis of the cerebro-spinal/

(1) Revue neurologique March 30th 1903.

(2) Ibid.

(3) Ibid.

(4) Med. Record. Jan 23rd 1904.

(5) Traite de Pathologie Générale (Bouchard.) Vol.6 p.619.

(6) Soc. Méd. des Hôpitaux. May 1901



spinal fluid has in many cases been demonstrated.

Sicard found it in all of 17 cases, and

Fraenkel <sup>(1)</sup> in all of three cases.

Siemerling <sup>(2)</sup> observed a lymphocytosis in 37 out of 38 cases and Mallet in 6 out of 8.

In general paralysis of the insane as in tabes, the lymphocytosis of the cerebro-spinal fluid is sometimes the earliest sign of the disease. Joffroy <sup>(3)</sup> found it in one case before any other characteristic sign of the disease appeared.

#### In Disseminated Sclerosis:-

Here also, a lymphocytosis of the cerebro-spinal fluid has been found in a large proportion of the cases examined.

Sicard <sup>(4)</sup> found it in only 2 out of 7 cases, but Carrière <sup>(5)</sup> in all of 3 cases he examined.

Fraenkel <sup>(6)</sup> found a marked lymphocytosis in six out of his seven cases.

- (1) Med. Record. January 23rd 1904.
- (2) Berlin. Klin. Wochenschrift May 23rd 1904.
- (3) Soc. Méd. des Hôpitaux June 7th 1901.
- (4) Ref. in Labbé's "Le cytodiagnostics."
- (5) Compte Rendus de la Société de Biologie March 1901.
- (6) Med. Rec. Jan. 1904.

In Syphilis of the Nervous System:-

Besides *Tabes dorsalis* and general paralysis of the insane which are usually the results of syphilis, there are other syphilitic conditions of the nervous system in which cytological examination of the cerebro-spinal fluid may give positive results.

Widal<sup>(1)</sup> has found a lymphocytosis in syphilitic hemiplegia and in many cases of syphilitic meningitis.

Sicard<sup>(2)</sup> found a lymphocytosis in all of 6 cases of syphilitic myelomeningitis, and Fraenkel<sup>(3)</sup> in two cases of the same disease, and also in a case of cerebral gumma.

In the headaches of the secondary and tertiary periods of syphilis the state of the cerebro-spinal fluid varies. In a few cases various kinds of cells were present, but in a great many cases the fluid has been found normal (Labbé<sup>(4)</sup>).

In Herpes Zoster:-

Sicard<sup>(5)</sup> found a lymphocytosis of the cerebro-spinal fluid in 7 out of 11 cases of herpes zoster.

(1) Soc. Méd. des Hôpitaux Feb. 14th 1902

(2) Ref. in Labbés "Le Cytodiagnostic."

(3) Med. Rec. Jan. 1904.

(4) "Le Cytodiagnostic"

(5) Soc. Méd. des Hôpitaux March 13th 1901.

Widal and Le Sourd <sup>(1)</sup> have also found a similar condition in several cases they examined.

Chauffard and Froin <sup>(2)</sup> in two cases, found during the first few days many large lymphocytes, and after the eruption had disappeared fewer and smaller lymphocytes. In one patient who still had pains in the region of the herpes, six months after the eruption had disappeared, they found a lymphocytosis still present. They hold that there is a relation between the intensity and the persistence of the pains and the lymphocytosis. This has been corroborated by the observation of Archard. <sup>(3)</sup>

#### In Mental Affections:-

In commencing alcoholic insanity, Dana <sup>(4)</sup> found a few lymphocytes present in most cases, and Duflos <sup>(5)</sup> got similar results, while in subacute delirium with hallucinations he usually found lymphocytes present in large numbers.

Séglas and Nageotte, Dupré and Devaux <sup>(6)</sup> have got negative cytological results in a great many cases of mental affections of different kinds.

(1) Ref. in Labbé's "Le cytodagnostic."

(2) Soc. Méd des Hôpitaux Nov. 21st 1902.

(3) Soc. Méd des Hôpitaux Jan. 17th 1902.

(4) Med. Record January 23rd 1904.

(5) Thèse de Paris 1901

(6) Soc. Méd. des Hôpitaux June 7th 1901



Having considered the different nervous diseases in which a cytological examination of the cerebro-spinal fluid has given as a rule positive results, one must now refer to some diseases in which the cytological examination of the cerebro-spinal fluid has negative results.

Nageotte and Jamet<sup>(1)</sup> examined the cerebro-spinal fluid in 37 cases of epilepsy and found it free from cells in all the cases.

In cases of neurasthenia, hysteria, polyneuritis, syringomyelia, hemiplegia due to vascular conditions and in compression myelitis the cytological examination of the cerebro-spinal fluid has uniformly given negative results (Sicard).

#### The Bacteriological Examination of the Cerebro-spinal fluid.

Three methods of examination may be used

- (1) film preparations, (2) culture growths
- (3) inoculation experiments.

The following bacteria have been found in the fluid.

- (1) Staphylococcus.
- (2) Streptococcus.
- (3) Pneumococcus - Fraenkel's diplococcus lanceolatus.
- (4) Meningococcus - the diplococcus intracellularis of Weischelbaum.
- (5) Typhoid Bacillus.

(1) Soc. Méd. des Hôpitaux Jan. 17th 1902.

Wentworth <sup>(1)</sup> observed a case of typhoid fever in a child four years old, who developed symptoms of meningitis on the twenty second day and died fourteen hours later. A post mortem lumbar puncture gave a turbid liquid containing many typhoid bacilli and cultures gave agglutination with serum from a case of typhoid.

Cabot and Neval <sup>(2)</sup> record another case of meningitis in the course of typhoid, apparently caused entirely by the typhoid bacillus. The bacillus was found in the cerebro-spinal fluid.

(6) Tubercle Bacillus.

(7) Influenza Bacillus. (Pleiffler's)

Streptococci and pneumococci are commonly found in cases of septic meningitis, the meningococcus in cases of cerebro-spinal meningitis and the tubercle bacillus in tubercular meningitis.

The detection of the streptococcus, the pneumococcus and the meningococcus is as a rule easy and they can often be seen in the film prepared for the cytological examination. The detection of the tubercle bacillus in the fluid, is usually much more difficult./

(1) Archives of Pediatrics. Nov. 1899.

(2) Lyon. Méd. March 9th 1903.

difficult.

The fluid should be allowed to stand till the network of fibrin is deposited. This is then picked out with a platinum needle and transferred to a slide. The film is fixed and stained in the usual way when examining for tubercle bacilli.

Different observers have had widely different experiences in regard to the proportion of cases of tubercular meningitis in which they were able to demonstrate the presence of tubercle bacilli. Most observers have found that the largest percentage of failures occurred in the earlier cases they examined, so their failures must to some extent be due to faulty technique.

Monte <sup>(1)</sup> failed to find tubercle bacilli in 15 cases of undoubted tubercular meningitis.

Lutier <sup>(2)</sup> got positive results in about half of 41 cases and Percheron <sup>(3)</sup> in 7 out of 16 cases.

Slawk <sup>(4)</sup> was most successful, finding the tubercle bacillus in 16 out of 19 cases.

Warrington <sup>(5)</sup> was able to find the bacillus in only two out of seven cases.

(1) Archives f. kinderkeilkunde. Bd. XXIV.

(2) Thèse de Paris 1900.

(3) Thèse de Paris 1900.

(4) Berliner Klin. Woch. May 2nd 1898.

(5) Brit. Med. Journ. Oct. 21st 1905.



The opinions of different observers about the value of inoculation experiments in suspected cases of tubercular meningitis are very contradictory.

Widal <sup>(1)</sup> got positive results in all of nine cases from which some of the cerebro-spinal fluid was injected into guineapigs, and he thinks the proceeding is of great value.

Percheron <sup>(2)</sup> on the other hand says that the fluid from a case of tubercular meningitis is often not sufficiently toxic when injected into animals to give reliable information.

The great objection to this method of examination is the time (4 to 6 weeks) which must necessarily elapse before results can be obtained.

The presence of the streptococcus, the pneumococcus and the meningococcus can also be demonstrated by the inoculation of guinea pigs, the first two being pathogenic to that animal when injected subcutaneously, the last only when injected into the pleural cavity. (Labbe <sup>(3)</sup>).

Other morphological elements besides cells and bacteria may occasionally be found in the cerebro-spinal/

(1) Soc. Méd. des Hôpitaux. No.7 p.131

(2) Thèse de Paris 1903

(3) "Le Cytodiagnostic."

spinal fluid.

Euriques and Sicard <sup>(1)</sup> report a case of primary actinomycosis of the brain in which they found the fungus in the cerebro-spinal fluid. The patient presented signs of a tumour of the cortex of the left hemisphere. Lumbar puncture was performed to relieve the excessive intracranial tension and microscopic examination of the fluid showed the fungus actinomycosis. Trephining had previously been done to try and relieve the compression symptoms but the result was only temporary. This cranial wound eventually suppurated and in the pus was found the characteristic mycelium of actinomycosis.. A post-mortem examination showed a tumour of the left fronto-parietal region, purulent at the periphery and communicating by a narrow opening with the lateral ventricle which explained the presence of the fungus in the cerebro - spinal fluid.

Trypanosomes are found in the cerebro-spinal fluid in cases of sleeping sickness (Mott <sup>(2)</sup> ).

(1) Soc. Méd. des Hôpitaux. May 13th 1904.

(2) Brit. Med. Journ. Dec. 10th 1904.



### THE PERMEABILITY OF THE MENINGES:-

Normally the pia-arachnoid membrane is impermeable from without inwards and substances taken by the mouth or injected under the skin do not pass into the cerebro spinal-fluid. On the other hand the membrane is permeable from within outwards, and substances injected into the cerebro-spinal fluid (methylene blue, iodide of potassium etc.) are absorbed and eliminated by the urine. Various observers have noted variations in the permeability of the pia-arachnoid in disease. In some pathological conditions it may become permeable from without inwards. In tubercular meningitis and acute, <sup>and</sup> chronic syphilitic meningitis this has been found, and iodide of potassium when given by the mouth in large doses has been found in the cerebro-spinal fluid. (Widal, Sicard and Monot.<sup>(1)</sup>) On the other hand in acute cerebro-spinal meningitis the membrane is impermeable (Sicard and Brécy<sup>(2)</sup>) Sicard also found the membrane permeable in two cases of ventricular haemorrhage.

Lére<sup>(3)</sup> however, in five cases of tubercular meningitis confirmed by autopsy could find no increased permeability of the meninges.

(1) Soc. de Biologie Nov. 3rd 1900

(2) Soc. Méd des Hôpitaux April 19th 1901.

(3) Archives de Méd. des Enfants Vol.V.



33a.

The results of these different observations are therefore too contradictory to allow any deductions of clinical value to be drawn from them.

THE VALUE OF LUMBAR PUNCTURE IN DIAGNOSIS  
AND DIFFERENTIAL DIAGNOSIS.

In meningitis:-

(a) Tubercular Meningitis:-

The fluid in the early stages is as a rule just slightly opalescent, and shows, when held up to the light, the characteristic cloud of highly refracting particles which have been likened to motes in a sunbeam. In the later stages the fluid is distinctly cloudy. When the fluid has stood for some hours it deposits a cobweb like coagulum of fibrin. The funnel shaped appearance of the coagulum is said to point strongly, when well seen, to the tubercular nature of the meningitis.

The fluid contains more albumin than normal fluid does, as in all cases of meningitis. The amount of reducing substance is usually much less than normal in the early stages, and in the later stages it is usually altogether absent.

In by far the largest proportion of cases, cytological examination of the fluid shows a marked lymphocytosis. In a certain number of cases a polynuclear leucocytosis has been found, but this has usually been found to coincide with a secondary infection with pyogenic organisms.

The/

The tubercle bacillus can be found in the fluid in many cases and inoculation experiments often prove the tubercular nature of the case.

(b) In other forms of meningitis.

In meningitis due to the streptococcus and pneumococcus and in cerebro-spinal meningitis caused by the meningococcus, the fluid presents all grades of turbidity from being almost clear to altogether purulent.

The same deposition of fibrin takes place as in tubercular cases, but the funnel-like shape of the coagulum is not so well seen as in tuberculous meningitis.

The amount of albumin is always more than normal.

The amount of reducing substance is as a rule much less than normal.

Cytological examination early in the case shows in almost all cases a marked polynuclear leucocytosis, later when the case is running a favourable course, this may be replaced by a lymphocytosis. In a few cases however a lymphocytosis has been found from the beginning.

Bacteriological examination of the fluid usually demonstrates the organism to which the condition is due.

The/



The chief points then in differentiating between tubercular and non-tubercular meningitis are

(1) the relative proportion of the leucocytes found in the fluid; a lymphocytosis being strongly presumptive though not absolute evidence of the tubercular nature of the case, and a polynuclear leucocytosis of its non-tubercular nature. Since a secondary lymphocytosis may follow the polynuclear leucocytosis in non-tubercular cases, care must be taken, if the examination has not been made till fairly late in the course of the case, not to take this secondary lymphocytosis of a non-tubercular case for the primary lymphocytosis of a tuberculous case.

(2) The positive finding in the cerebro-spinal fluid of the bacterium which is causing the meningitis.

In the differential diagnosis of a meningitis from other conditions simulating it, i.e. the meningeal symptoms of typhoid, pneumonia and other acute diseases which are due to the irritation of the meninges by toxins circulating in the blood, we base our diagnosis of a true meningitis on

- (1) the deposition of a coagulum on standing
- (2) the abundant presence of cells in the fluid.

Neither/

Neither of these is present when the symptoms are not due to a definite and distinct meningitis.

Ceconi has pointed out also that cryoscopic examination of the fluid helps us to distinguish a true meningitis from the above conditions simulating it. He holds that the depression of the freezing point below the normal limits ( $0.60^{\circ}\text{C}.$  to  $0.64^{\circ}\text{C}.$ ) points to the existence of a meningitis. Though this method of examination of the cerebrospinal fluid promises to be of value in the future, we have as yet too little experience of it to place much reliance upon it.

The differential diagnosis by lumbar puncture between meningitis and tumour of the brain will be considered later.

#### IN BRAIN TUMOUR:-

The fluid is clear and does not deposit a coagulum on standing. Cytological examination gives as a rule negative results. The albumin and reducing substance are present in normal amount. The pressure of the fluid is as a rule enormously increased. Sometimes however one fails to obtain any fluid at all. This is thought to be due in some cases to the tumour pressing down the pons and medulla into the foramen magnum and so occluding the cerebral from the spinal cavity.

Differential diagnosis of tumour from meningitis.

In cases of tumour one finds:-

- (1) the fluid is clear.
- (2) the fluid does not deposit fibrin.
- (3) no cells present in the fluid.
- (4) the albumin and the reducing substance are present in normal amount.

whereas in meningitis one finds:-

- (1) the fluid usually turbid.
- (2) it deposits a coagulum on standing.
- (3) contains abundant cells.
- (4) the albumin is increased and the reducing substance diminished.

In head injuries:-

The cerebrospinal fluid is found to be blood-stained in fractures of the skull with rupture of the dura mater and also in cases of severe laceration of the brain with rupture of the pia mater. It is however rare to get a severe laceration of the brain substance with rupture of the pia mater without a fracture as well.

The presence of blood in the cerebro-spinal fluid, after a severe injury to the head is therefore strongly presumptive evidence of the existence of a fracture/



fracture of the skull. As fractures of the vault can usually be felt when they are severe enough to cause rupture of the dura mater, the finding of blood stained cerebro-spinal fluid with no other signs of a fracture, makes the diagnosis of a fracture of the base of the skull almost certain. The presence of blood in the cerebro-spinal fluid from a concussed patient shows that something more than simple concussion is present, as in cases of simple concussion of the brain one never finds the cerebro-spinal fluid blood-stained.

It must also be remembered that one may find blood-stained cerebro-spinal fluid in cases of cerebral haemorrhage, when the haemorrhage is subdural or when a haemorrhage into the substance of the brain has ruptured into the ventricles. Therefore when a patient is found unconscious with signs of head injuries and blood-stained cerebro-spinal fluid is obtained, one must remember that a cerebral haemorrhage may have been the cause of his fall and the resulting head injuries, and that the presence of blood in the cerebro-spinal may be due either to a cerebral haemorrhage or to a fractured skull.

#### IN NERVOUS DISEASES:-

A lymphocytosis of the cerebro-spinal fluid has been proved to occur in a great many cases of tabes/

tabes dorsalis, general paralysis of the insane, and in syphilitic diseases of the central nervous system generally. This never occurs in cases of peripheral neuritis, syringomyelia, hemiplegia due to vascular causes, hysteria and neurasthenia, nor in mental affections other than general paralysis of the insane. This lymphocytosis is found in atypical as well as typical cases of tabes and general paralysis of the insane, and has been observed in the very earliest stages of these diseases, before any other characteristic signs have developed. This fact will prove of value in the differential diagnosis between suspected cases of these diseases and other conditions which may simulate them and in which the cerebro-spinal fluid is devoid of cells. For instance in a patient with loss of knee jerk and no other symptoms, and in which the diagnosis lay between tabes and peripheral neuritis, the demonstration of a lymphocytosis of the cerebro-spinal fluid would favour the diagnosis of an atypical case of locomotor ataxia, as a leucocytosis of the fluid is not found in peripheral neuritis. Likewise a lymphocytosis of the cerebro-spinal fluid would help in diagnosing an early or atypical case of general paralysis of the insane from other mental affections.

A/

A lymphocytosis of the cerebro-spinal fluid is also found in many cases of disseminated sclerosis. As the diagnosis of this disease in its early stage from hysteria is generally acknowledged to be often exceedingly difficult, the value of an early examination of the cerebro-spinal fluid cannot be over-estimated. The presence of cells in the fluid will at once exclude a hysterical condition.

The presence of cells in the cerebro-spinal fluid may be taken to indicate some organic affection of the central nervous system and to altogether exclude a neurotic or hysterical condition.

#### THE THERAPEUTIC VALUE OF LUMBAR PUNCTURE.

Lumbar puncture is employed as a therapeutic procedure with two objects

- (1) to reduce excessive intracranial pressure
- (2) to remove toxic substances present in the cerebro-spinal fluid.

In cases where, with symptoms of compression of the brain, a high pressure of the cerebro-spinal fluid is found, lumbar puncture provides us with an easy and safe means of reducing this excessive pressure by the abstraction of some of that fluid.

Quinke <sup>(1)</sup> pointed/

(1) Berlin. Klin. Woch. October 14th 1895.



pointed out that in acute cases, in addition to relieving the excessive pressure at the time, the abstraction of some of the fluid also acts beneficially by removing the pressure on the lymphatic ducts which once more become permeable and regain their power of absorption.

Where bacteria and their toxins are present in the cerebro-spinal fluid, the removal of a quantity of that fluid containing some of these bacteria and their toxins might be expected to do some good. The fresh fluid which is poured out to take the place of that removed may possibly have some active bactericidal power.

#### THE THERAPEUTIC VALUE OF LUMBAR PUNCTURE IN MENINGITIS.

##### (a) In tubercular meningitis:-

Before the introduction of lumbar puncture the tubercular nature of a case of meningitis that recovered could not be positively asserted. Now however one can, by the examination of the cerebro-spinal fluid, prove in most cases the exact nature of the meningeal inflammation, and a few cases in which such examination has proved the case to be tuberculous, have ended in recovery.

Barth/

Barth<sup>(1)</sup> recorded a case of a child who showed signs of meningitis, and in whose cerebro-spinal fluid tubercle bacilli were found. After an illness lasting six months recovery ensued.

Claisse and Abrami<sup>(2)</sup> report a case which is interesting not only because it ended in recovery, but also because of the changes noted in the cerebro-spinal fluid at different times during the illness. Their patient was a man who was admitted to hospital with signs and symptoms suggesting tubercular meningitis. The first lumbar puncture made on the 14th day of the disease gave a fluid which coagulated on standing and contained many leucocytes. The patient's condition was much improved and a second puncture three days later showed a fluid less rich in fibrin and albumin and containing fewer cells. A third puncture made at the end of a month from the beginning, the patient now being convalescent, gave a perfectly normal fluid. Though they were unable to demonstrate tubercle bacilli in the cerebro-spinal fluid, the tubercular nature of the case was proved by inoculation experiments, two guinea pigs into which some of the fluid from the first puncture was injected developing tuberculosis./

(1) Munich Med. Woch. 1902 No.21.

(2) Soc. Méd. des Hôpitaux. May 12th 1903.

tuberculosis.

Other cases of tubercular meningitis which have ended in recovery have been recorded, but they need not be cited here.

Though lumbar puncture has proved the possibility of recovery from tubercular meningitis, the whole credit for bringing about these recoveries cannot be ascribed to the lumbar puncture performed, as in the vast majority of the cases in which lumbar puncture has been performed no permanent benefit has been derived from it. The temporary improvement in these cases after the removal of some cerebro-spinal fluid is however very striking. The author has repeatedly seen the convulsions stopped, the muscular rigidity diminished and the headache apparently lessened by the reduction of the cerebro-spinal pressure to about the normal degree by the removal sometimes of considerable amounts of fluid:— half an ounce or more.

All that can be claimed then for lumbar puncture in the treatment of tubercular meningitis is, that it relieves for a time the symptoms of compression due to the excessive intracranial tension and thus, by removing for a time a condition immediately fatal to life, increases the possibility of a spontaneous recovery in these cases.

(b)/



(b) IN PURULENT MENINGITIS:-

In cases of meningitis due to infection by the streptococcus or the pneumococcus the benefit resulting from lumbar puncture has been found to be exceedingly small. Some observers have however claimed to have found it of some considerable value.

Lermoyez and Bellin <sup>(1)</sup> in discussing the treatment of acute purulent meningitis resulting from ear disease, hold that, in addition to clearing out the ear and incising the dura mater, repeated lumbar puncture is a most important and necessary part of the treatment. The subtraction of the fluid, they say, must be abundant (at least 15 c.c. at a time), and it must be repeated as soon as the temporary improvement produced by the preceding puncture passes off. Besides relieving the severe pains in the head and the vomiting and making the patient for the time being, much more comfortable, they think that in some cases it has had a permanently curative effect as well.

The vast majority of observers however have found no good to result in these cases from lumbar puncture and when we consider the pathology of the condition and our experience of suppurative processes in other parts of

(1) International Clinics. Vol. II. 15th series.

of the body due to these organisms, it is difficult to see how much good can be expected to result from lumbar puncture. Though theoretically the removal of a certain amount of cerebro-spinal fluid containing the bacteria and their toxins ought to be of some value, we know that in cases of purulent collection in other situations simply drawing off the purulent matter and making no provision for drainage does very little good. It does not therefore seem rational to expect that simply drawing off a little of the purulent fluid from a complicated cavity like the subarachnoid space, will have much permanent effect on the course of a case of purulent meningitis.

(c) IN CEREBRO- SPINAL MENINGITIS:-

Lumbar puncture has lately been largely tried in the treatment of cases of this disease, of both the epidemic and sporadic variety.

Seager<sup>(1)</sup> recorded his experiences of this method of treatment during the epidemic at Lisbon. He tried the effects of simple lumbar puncture in one group of cases, and of lumbar puncture followed by the injection of a solution of lysol and artificial serum in another set of cases. It will be as well to give his/

(1). Lancet. November 1st 1902.



his account of the latter method of proceeding in his own words. "The fluid drawn off in the early stages by lumbar puncture is clear and limpid during which time the temperature falls as low as 95°F. After periods varying from hours to days the fluid becomes flocculent and contains pus, and the temperature may rise to 104°F. When the temperature has risen (generally when at its height), a puncture is made with a hypodermic needle and a quantity (frequently 50c.c.) of cerebro-spinal fluid is removed. Artificial serum is then injected through the same needle, and lastly a quantity (from 9 - 12 c.c.) of a 1% solution of lysol is injected. The temperature falls immediately but rises again after two or three days, when the same proceeding is repeated, and so on till quite clear and limpid fluid is obtained when the injection of lysol is stopped. A few punctures are afterwards made to see if the fluid remains clear."

Seagar summarises the results of the different methods of treatment thus:-

Under old treatment (hot baths and ice cap)

the mortality was 60%

With simple lumbar puncture, nine cases died out of twenty cases so treated, representing

a mortality of 45%

With the lysol treatment, 13 cases out of 31 died, a mortality of

42%



He also quotes 26 cases treated by simple puncture during the epidemic in Oporto in 1901.

Eight of these cases died, representing a

mortality of 31%

while of the other 65 cases not treated by

lumbar puncture 56 died, i.e. a mortality of 86%

Manges (1) reports three cases of cerebro-spinal meningitis treated by lumbar puncture and the injection of lysol in the way described by Seagar. All three cases ended in recovery.

Netter (2) has also recorded a case which recovered after treatment by repeated lumbar punctures. From the second to the thirty-seventh day eleven punctures were made at intervals of two to five days, 30 to 70 c.c. being withdrawn at each time. The first puncture gave a fluid with a deposit of pus, the second two days later a fluid with a slight sediment, and the third, fluid with a very slight fibrinous flake. After this the fluid became quite clear and Netter thought that the withdrawal of fluid has been of benefit.

Another/

(1) Med. News. May 14th 1904.

(2) Archives de méd des enfants July 1900.

Another striking case has been reported by Donelan.<sup>(1)</sup> The patient, a man aged fifty, was on the 5th day of the disease lying in a semiconscious state with severe occipital headache and marked rigidity of the neck. Slight aphasia was also present. Lumbar puncture was done and four ounces of turbid fluid rushed out with considerable force. The patient was much better immediately after and was conscious in a few hours, and the pain, muscular spasm and aphasia disappeared in about two days and he had completely recovered in two weeks. The examination of the fluid revealed polynuclear cells some of which contained the diplococcus intracellularis.

Tobler<sup>(2)</sup> performed lumbar puncture in seven cases of sporadic cerebro-spinal meningitis, and of these seven cases three recovered.

In estimating the value of lumbar puncture in the treatment of cerebrospinal meningitis one must remember that the cases vary very much in severity and that it is by <sup>no</sup> <sup>necessarily</sup> means a fatal disease. Tobler goes so far as to say that in its sporadic form at any rate, the natural tendency of cerebrospinal meningitis is towards recovery. The mortality rate in different/

(1) Brit. Med. Journ. May 27th 1905.

(2) Corres - Blatt für Schweizer Aertze. April 1st 1905,



different epidemics has varied from 20% to 70%. Hence it is difficult from the limited number of cases recorded to draw very definite conclusions as to the value of lumbar puncture in its treatment.

Seager's observations however extend over a sufficient number of cases to allow some deduction to be drawn from them and his statistics show that of cases treated by lumbar puncture alone and by lumbar puncture with the subsequent injection of lysol, a much larger number recover than with any other treatment. Only a slightly greater percentage of cases recovered with the lysol treatment than with simple puncture so that the injection of lysol does not seem to produce any very marked benefit.

It appears then, permissible to say that lumbar puncture does do some good in cerebro-spinal meningitis and as there is no other very satisfactory treatment, the results already obtained by lumbar puncture warrants its further trial in the treatment of this disease. By relieving the excessive intracranial tension and removing some of the toxins present in the cerebro-spinal fluid it may improve for a time the patient's condition, and make him more able to fight against the disease.



IN HEAD INJURIES:-

A great deal has lately been written about the value of lumbar puncture in the treatment of cases of concussion, both simple and associated with fractures of the skull, especially of the base. That it is of considerable value in lessening the coma and the severe pains in the head so often present in these cases is agreed upon by most writers.

Quenu (1) thinks that the good effects of lumbar puncture, in cases of fractured base are due to (1) relief of excessive intracranial tension, resulting from the effusion of blood and the hypersecretion of cerebro-spinal fluid, and (2) to the removal of toxic elements formed by the effused blood which act injuriously on the nerve centres.

M. Rochard, in the course of a discussion by the Société de Chirurgie de Paris, stated that he was so convinced of the good which results from lumbar puncture in cases of fractured base, that he employed it as part of the routine treatment of all his cases.

In many severe cases of fractured base of the skull in which I have seen lumbar puncture performed, the benefit apparently due to the effects of the puncture have often been marked. The coma has in many/

(1) Bull. et Mém. de la Soc. de Chir. de Paris.

many cases been very soon lessened, and the severe pains in the head relieved sometimes very quickly.

How far the lumbar puncture assists in promoting ultimate recovery in these cases is however difficult to say, as nowadays with the careful antiseptic cleansing of nose and ears, many severe cases of fractured base ultimately recover without any interference.

In one case of simple concussion which came under the writer's observation the effects of lumbar puncture were very striking. The case has already been published by Eve.<sup>(1)</sup> A boy was admitted to hospital with a history of having been hit on the head with a bat. For a week he lay in a drowsy apathetic condition with headache, facial twitchings, and occasional vomiting. Lumbar puncture showed a pressure equal to 10 inches of water. Half an ounce of fluid was drawn off and he was much more comfortable and next morning was quite bright and cheerful.

In all these cerebral conditions following injuries to the head, the good effects of lumbar puncture are presumably due chiefly to the lowering of the increased intracranial tension present in many of the cases.

(1) Lancet. April 22nd 1905.



### IN HYDROCEPHALUS:-

The fact that lumbar puncture was first used by Quinke for the treatment of this disease, makes the study of its therapeutic value in this condition especially interesting. Since Quinke advocated this treatment, many others have tried it but the results taken all over have been disappointing. A few writers have however recorded cases of hydrocephalus in which removal of fluid by lumbar puncture has been of some permanent value.

Von Bokay<sup>(1)</sup> reports good results from repeated lumbar punctures in cases of chronic internal hydrocephalus. He withdraws small amounts (50 - 60 c.c.) at intervals of about four weeks. He found in most cases that the communication between the ventricles and the subdural space was still patent. This is of course necessary for the success of the treatment by lumbar puncture.

Cantley<sup>(2)</sup> reports the cure by repeated punctures of a case of hydrocephalus, secondary to basal meningitis in a child.

Most observers have however found that the good resulting in these cases from lumbar puncture is as a rule only very temporary. Taken all over, the results/

(1) Jahrb. f. Kinderheilk. 1903 Bd. 57.

(2) Lancet. November 1st 1902.



results are much the same as with ventricular aspiration, but as lumbar puncture allows of a slower removal of the fluid and is altogether a less serious operation than tapping the ventricle, it is the preferable of the two proceedings.

#### IN URAEMIA:-

Several cases in which lumbar puncture has seemed to be of value in ending the coma of acute uraemia have been recorded.

Mc.Vail<sup>(1)</sup> reports two cases. In both cases the patients began to regain consciousness in about four hours and recovered. One patient got completely well and the other showed only a slight trace of albumin. Mc.Vail thinks that the convulsions and coma of acute uraemia are due in some, if not in all cases to increase of intracranial pressure, and that this may be relieved by lumbar puncture. In one case (already published by Eve<sup>(2)</sup>) in which I saw lumbar puncture performed for uraemic coma with total blindness, the improvement which followed seemed largely due to the effects of the puncture. The patient was a middle aged man. The convulsions previously/

(1) Brit. Med. Journ. October 24th 1903.

(2) Lancet April 22nd 1905.

previously present had been relieved by venesection but the coma remained. Lumbar puncture was then done and the coma soon began to get less deep, and next morning the patient was quite conscious and the blindness which was due to optic neuritis was markedly less.

#### In the Headaches of Chronic Nephritis

Lagrain and Guiard <sup>(1)</sup> recommend lumbar puncture in treating the persistent headaches of chronic nephritis when other methods have failed. It may, they say, be repeated every two to four weeks.

Guillian and Marie <sup>(2)</sup> recorded a case which resisted all other treatment but was at once cured by lumbar puncture and the removal of 6 c.c. of fluid.

These cases point to excessive tension of the cerebro-spinal fluid as the cause of the severe headaches in chronic nephritis.

#### In Puerperal Eclampsia:-

Proud <sup>(3)</sup> records two cases of severe eclampsia which were cured by lumbar puncture after other/

(1) Progrès Méd. 1903 No.44.

(2) La Sem. Méd. 1901 p.157.

(3) Brit. Med. Journ. March 24th 1906.

other remedies had failed. The fits ceased and consciousness began to return soon after the puncture

#### In Diseases of the Ear:-

Babinski<sup>(1)</sup> has recorded his observations of the effects of lumbar puncture on various auricular troubles. He holds that there is a relation between the pressure of the cerebro-spinal fluid and that of the fluid in the labyrinth of the ear. He found that cases of vertigo were markedly benefited, 21 were cured out of 32. Cases of tinnitus were benefited less often, 30 out of 90 were distinctly improved. Cases of deafness were generally benefited little, especially when unaccompanied by tinnitus and vertigo. Only 13 patients out of 100 were any better, but some of these were remarkably improved. For instance an old lady who had been deaf for ten years was able to hear whispering at a distance of six feet.

The results of Babinski's work warrant further investigation into the therapeutic value of lumbar puncture in these auricular troubles.

#### In Urinary Incontinence:-

Babinski and Boisseau <sup>(2)</sup> treated several cases of enuresis and incontinence of urine by lumbar puncture with success.

(1) Bull et Mém. de la Soc. Méd. des Hôpitaux de Paris. Nov. 7th 1902

(2) Soc. Méd. des Hôpitaux de Paris. April 21st 1904.



(1) a young woman, aet.17, had had enuresis since she was seven. After lumbar puncture and withdrawal of fluid she had no more incontinence for eight days. From the 9th to the 13th day she had incontinence twice. A second puncture was made and though she had incontinence on the 5th and 17th day after this, she had had no more two months after.

(2) a child, aged 14, had had incontinence day and night for six weeks. Belladonna had failed, but after lumbar puncture the diurnal incontinence disappeared altogether, but the nocturnal incontinence reappeared after two months, only occurring however about every fourth night. A second lumbar puncture was followed by the complete disappearance of the nocturnal enuresis.

(3) The third patient was suffering from spastic paraplegia of two years duration. He had incontinence of urine and faeces. A lumbar puncture was done and 15 c.c. of fluid were withdrawn. The patient had no more incontinence but could pass water voluntarily, and felt the need of passing it and the passing of the urine which had never been so previously.

Babinski and Boisseau do not pretend to explain how lumbar puncture acts in these cases. It is difficult to see how the extraction of a small amount of cerebro-spinal fluid can permanently influence the incontinence/

incontinence of chronic conditions like spastic paraplegia, and here, as in enuresis, the mental effect of the operation may be the chief factor in bringing about a cure. It is however a subject worthy of further investigation.

While discussing the therapeutic uses of lumbar puncture, two other proceedings which involve a preliminary puncture of the spinal membranes may be mentioned. These are the intraspinal injection of anti-tetanic serum in cases of tetanus, and the induction of anaesthesia by the injection within the spinal membranes of solutions of cocaine and stovaine.

The question of the comparative values of the intraspinal and subcutaneous methods of the injection of anti-tetanic serum is still "sub judice." Some good results have been obtained when the serum has been injected into the subarachnoid space, and there is every reason to expect that this method may improve the results of the treatment of tetanus.

The use of cocaine for the production of anaesthesia by intraspinal injection has been practically given up owing to the after effects of the drug, but since the introduction of stovaine this substance has been widely used for the same purpose. //



purpose, and the results obtained have been extremely satisfactory. This promises to be in future one of the most useful therapeutic applications of lumbar puncture.

#### THE DANGERS AND COMPLICATIONS OF LUMBAR PUNCTURE.

Though as a rule no unpleasant after effects follow the use of lumbar puncture, one occasionally finds temporary malaise, headache, giddiness and neuralgias, but these symptoms usually soon pass off.

Puncture of one of the veins lying behind the bodies of the vertebrae may cause the formation of a clot of blood, with resulting symptoms of irritation of the nerve roots as in a case described by Rollerton and Tebbs.<sup>(1)</sup> In this case, one of tubercular meningitis in a boy, lumbar puncture was followed by a bullous eruption on the legs. Post-mortem, a blood clot three inches long was found under the arachnoid in contact with the posterior nerve roots and cauda equina on the right side. This clot, which was evidently the result of the lumbar puncture, was thought to have irritated the posterior nerve roots and ganglia and so caused the eruption.

Sudden death has several times followed lumbar puncture in cases of tumour of the brain. Gumprecht <sup>(2)</sup> records/

(1) Lancet. December 3rd. 1904.

(2) Deut. Med. Woch. June 14th 1900.



records two such cases. It is said to be especially dangerous in tumours near the base of the brain and the explanation given is that the cerebro-spinal which in these cases is generally present in increased quantities, acts as a support to the tumour, and that when the fluid is withdrawn the brain sinks into foramen magnum and presses on the vital centres.

In children and delirious patients there is some danger of the needle breaking and part remaining in the tissues, but if one makes sure that the needles are well tempered and not brittle, and care is taken to prevent struggling on the part of the patient, this danger is small. It has however happened in several cases and a pretty extensive operation is sometimes necessary to remove the fragment of needle.

As the introduction of septic material into the subarachnoid space would necessarily be extremely serious, the importance of careful aseptic precautions in carrying out the operation is obvious.

Ossipow, as has been stated before, has found that aspiration of the fluid by a syringe is followed in some cases in dogs by haemorrhage into the spinal canal and he points out that the same effects may be produced in man. In several of the cases in which sudden death has followed the withdrawal of some fluid /

fluid by lumbar puncture this fluid was obtained by aspiration. The general opinion now is that aspiration of the fluid is dangerous and should never be resorted to.

Lumbar Puncture is contra- indicated in cases of apoplexy, cerebral softening and embolism as the lowering of the pressure of the cerebro-spinal fluid is apt to favour haemorrhage.

Where the existence of a tumour of the brain is diagnosed, lumbar puncture should be avoided owing to the fear of sudden death following it in these cases.

#### CONCLUSION:-

Lumbar Puncture has, up to the present time, proved of much more value as a diagnostic aid than as a therapeutic agent. It is in the diagnosis of meningitis, some organic diseases of the brain and spinal cord, such as tabes dorsalis and general paralysis of the insane, and of fractures of the base of the skull, that we get most help from the information furnished by lumbar puncture.

Therapeutically/